LOWER BLUE CREEK RECONNAISSANCE OF STORED SEDIMENT TECHNICAL MEMORANDUM

Midnite Mine Superfund Site – Spokane Indian Reservation, WA

Revision 2

September 2015

Prepared for:

Newmont USA Limited

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MWH®

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LIST OF ACRONYMS

amsl	above mean sea level
BMP	Best Management Practice
BODR	Basis of Design Report
cfs	cubic feet per second
CM	Conceptual Model
DNR	Spokane Tribe of Indians Department of Natural Resources
EPA	Environmental Protection Agency
MNR	Monitored Natural Recovery
Newmont	Newmont USA Limited
RD	Remedial Design
ROD	Record of Decision
Site	Midnite Mine Superfund Site
USGS	United States Geological Survey

1.0 PURPOSE AND OBJECTIVES

Field reconnaissance of the lower Blue Creek drainage was performed to characterize fluvial geomorphology of the stream and identify areas of sedimentation. This study only evaluated the presence of sediment and did not sample sediment to determine sediment quality. This technical memorandum describes the reconnaissance process, presents observations and the data collected, and a conceptual model of sediment transport and deposition in lower Blue Creek. This reconnaissance also supports the development of the Blue Creek and Delta Assessment Work Plan and evaluation of the monitored natural recovery (MNR) remedy for lower Blue Creek (see Section 1.2).

As described by MWH (2015b), specific objectives of the March 2015 field reconnaissance were:

- Identify and map sediment deposits within the lower Blue Creek drainage
- Quantify sediment thickness and sediment surface area to calculate a rough volume estimate (+/- 50%) for each area
- Report the findings in a brief technical memorandum utilizing maps to show depositional areas (e.g., beaver ponds), probe locations, measured sediment thicknesses and photographs of each area. In addition, a rough estimate of sediment volumes will be presented for the areas identified.

These objectives were modified during the field effort, as summarized in email correspondence between Newmont, MWH, and EPA (MWH, 2015c), and it was not possible to collect sufficient data within the two-day effort to meaningfully quantify sediment volumes throughout lower Blue Creek.

In addition to the narrative summary of the field effort, this memorandum includes:

- Summary of reconnaissance stations and measurements (Tables 1 through 3)
- Site and location maps (Figures 1 through 4)
- Conceptual hydrologic flow model and typical stream profile graphic (Figure 5)
- Lower Blue Creek longitudinal elevation profile (Figure 6)
- Lower Blue Creek historical hydrograph (Figure 7)
- Field photo log (Appendix A)

- Field notes (Appendix B)
- Relevant correspondence (Appendix C)

1.1 SITE DESCRIPTION

The Midnite Mine Superfund Site (Site) is an inactive open-pit, hard rock uranium mine that operated between 1955 and 1981 and occupies approximately 350 acres. Midnite Mine is approximately 45 miles northwest of Spokane, Washington and 8 miles northwest of Wellpinit, Washington (see **Figure 1**) and is located on the Spokane Indian Reservation in Stevens County at an elevation ranging from approximately 2,500 to 3,400 feet above mean sea level (amsl).

Three unnamed tributaries (referred to as the Eastern, Central, and Western Drainages) are within the mined area boundary. These mine drainages combine into the Mine Drainage before discharging to lower Blue Creek west of Turtle Lake. Blue Creek originates at Turtle Lake southeast of the mine site at 2,460 feet amsl. It then flows approximately 6.8 miles, dropping to an elevation of 1,280 feet amsl at its delta on the Spokane Arm of Lake Roosevelt. **Figure 2** depicts the Blue Creek watershed (approximately 13,440 acres), and the primary Midnite Mine watershed (approximately 807 acres or 6 percent of the Blue Creek watershed).

For the purposes of this reconnaissance, lower Blue Creek is defined as the approximately 4 mile section of lower Blue Creek from the Mine Drainage discharge into lower Blue Creek to the Blue Creek Delta (i.e., where Blue Creek flows into Lake Roosevelt), a drop of 800 feet and average gradient of 3.8 percent. Lower Blue Creek was broken into three distinct segments or reaches (upper, middle, and lower) as described in Section 3.0.

1.2 SELECTED REMEDY

The *Midnite Mine Superfund Site Spokane Indian Reservation, Washington - Record of Decision* (ROD; EPA, 2006) identifies EPA's Selected Remedy for the Site. The ROD includes actions to contain on-Site mine wastes and to prevent mine-impacted sediments from migrating off-Site. The Selected Remedy requires monitoring of lower Blue Creek and its delta to assess natural recovery of sediments (i.e., monitored natural recovery [MNR]), and the possible need for active remediation. The remedial design (RD) for the Selected Remedy is presented in the *Midnite Mine Superfund Site 100% Basis of Design Report* (BODR; MWH, 2015a). A *Blue Creek and Delta Assessment Work Plan* (Work Plan; MWH, 2011) - which was not approved by EPA and is still considered a draft document - was prepared as part of the overall RD to

establish procedures to characterize baseline conditions in lower Blue Creek sediments and identify conditions that would trigger active remediation. The reconnaissance summary presented in this memorandum supports ongoing development of the *Work Plan*, and future remedial action decisions for lower Blue Creek.

2.0 LOWER BLUE CREEK RECONNAISSANCE ACTIVITIES

The reconnaissance of lower Blue Creek was performed as described in an email dated January 28, 2015 (MWH, 2015b; included in Appendix C), which presented the proposed Purpose and Objectives and Survey Methods, and as described in subsequent email correspondence (MWH, 2015c; included in Appendix C). The lower Blue Creek reconnaissance was performed March 8 and 9, 2015 by MWH staff (Vance Drain and Peter EerNisse) accompanied by members from Spokane Tribe of Indians Department of Natural Resources (DNR; Brian Crossley), and Newmont (Randy Abrahamson). A CH2MHill professional Daniel Malmon (representing EPA) visited the Site for approximately 2 hours on the second day to observe the activities and discuss the preliminary reconnaissance findings (CH2MHill, 2015; included in Appendix C).

The reconnaissance activities included driving along the lower Blue Creek road, recording observed conditions and then stopping and collecting data at select locations along the lower Blue Creek where sediments were thought to exist and could be observed. The selected locations included many of the observed beaver dams and numerous stream profiles between the dams throughout lower Blue Creek to evaluate sediment deposition within the channel and on the adjacent benches. Measurements of stream features were accomplished with a stadia rod, laser level/measuring device, and GPS instrument. Sediment samples were not taken and sediment quality was therefore not determined. A summary of activities is presented below. Stream locations observed and measurements collected at these locations are summarized and depicted in the following tables and figures:

- **Table 1** presents a summary of beaver pond and beaver dam measurements.
- **Table 2** presents a summary of stream profile measurements.
- **Table 3** presents a summary of the physical characteristics measured and observed in the upper, middle and lower reaches of lower Blue Creek.
- **Figure 3** depicts the stream profile and beaver pond locations that were measured/observed on the upper reach of lower Blue Creek.

- **Figure 4** depicts the stream profile and beaver pond locations that were measured/observed on the lower reach of lower Blue Creek.

Please note that a figure is not provided for the middle reach of lower Blue Creek because of access and other issues as described in Section 2.1. A photo log of the reconnaissance is presented in Appendix A; field notes are presented in Appendix B, and relevant communications are presented in Appendix C.

2.1 DESCRIPTION OF ACTIVITIES

Streambed and sediment observation/measurement locations began at the confluence of lower Blue Creek with Lake Roosevelt and were established at irregular intervals along lower and upper reaches of Blue Creek. The overall lack of sediments observed during the reconnaissance in March 2015 in the lower Blue Creek channel prompted a rethinking of the original reconnaissance plan with regard to measuring sediment thickness.

Specifically, the plan was modified to include evaluation of the alluvial/colluvial deposits on the benches located immediately adjacent to the channel and into which the stream channel is incised. Measurement locations were focused on areas of depositional stream-morphology and controlled somewhat by access limitations. The bench width, the areal extent of the bench in the vicinity of each stream profile, and other observations were recorded to develop a conceptual model of the possible distribution of sediments with concentrations in excess of cleanup concentrations.

Not all observed benches were measured because the alluvial/colluvial benches exist to varying degrees all along the length of the upper and lower Blue Creek reaches. The visited/measured locations are meant to serve as a representative sample of bench characteristics.

Specific measurements and observations gathered at the stream profile locations are listed below and presented in Tables 1, 2, and 3:

- GPS line measurements perpendicular to the stream channel to ascertain channel width, alluvial/colluvial bench width, and length of beaver dams (where present).
- Overall height of the alluvial/colluvial bench above the stream bed was measured using a stadia rod held in the creek bed and a laser level to sight the stadia rod from the bench top. Attempts to probe the bench deposits with a hammer and rebar revealed them to be relatively dense with a uniform density with depth (i.e., there was no clear distinction

between flood-sourced deposits which might be softer and denser underlying bench materials). In general, the bench deposits were gravelly sandy silts, similar in character to the adjacent hillside soils (e.g., Lake Missoula flood deposits in the lower reach of lower Blue Creek), as opposed to softer materials that would be characteristic of flood deposits[1]. Because the benches appeared to be more colluvial in nature (as opposed to alluvial), and because there was a lack of softer unvegetated flood-sourced deposits on the benches that could be feasibly probed by hand, probing efforts were not conducted after the initial attempt.

- Stream type or character was observed (i.e., pool, riffle, run) and streambed sediment composition (documented with photographs), and stream width was measured.

Typical lower Blue Creek channel cross section measurements locations are depicted in **Figure 5** (inset).

Additional reconnaissance was performed by DNR personnel on March 30, 2015 to measure sediment thickness at the two largest beaver dams shown on **Figure 3** located near the confluence of the Midnite Mine Eastern Drainage and lower Blue Creek. These data also are included on **Table 1**.

A deviation from the Survey Methods listed in the January 28, 2015 email (see Appendix C) was that the middle reach of lower Blue Creek was not surveyed during the reconnaissance. The middle reach of lower Blue Creek was not surveyed because depositional areas and beaver ponds were not identified from vantage points along Blue Creek Road, and creek access is much more difficult because of the steeply plunging sidewalls and confined stream-channel

[1] *This report describes various processes related to the formation of the bench deposits including colluvial and alluvial processes, or a combination of both. It is possible under any of these scenarios that contaminated sediments could exist in these areas. The discussion regarding the possible colluvial origin of the bench materials here is intended to explain the field-decision to not collect depth measurements via probing.*

corridor characteristics of this middle segment of lower Blue Creek. Because of these factors, it was determined that accessing and collecting measurements in this middle reach exceeded what was feasible during the two-day reconnaissance.

3.0 RECONNAISSANCE FINDINGS

During the field work, it became apparent that the lower Blue Creek drainage can be separated into three reaches with regard to stream gradient, stream flow, and sediment deposition. The three reaches are depicted in **Figure 1**, and an elevation profile of lower Blue Creek, also depicting the three reaches, is presented in **Figure 6**.

1) The uppermost reach runs from the outfall of the Midnite Mine Drainage to the point where the stream channel becomes confined within steeper side-canyon walls. This upper reach contains depositional areas, including a number of recent beaver ponds and two older, larger beaver dams/ponds.

2) The second or middle reach has a steeper gradient than the lower reach. This middle reach is confined in a canyon and has a deeply incised channel with steep sidewalls. This more confined middle reach is dominated by erosional forces and the creek appears to be one continuous riffle. As discussed above in Section 2.1, the middle reach was only observed from Blue Creek Road (no measurements were collected, and no beaver dams were observed along this reach).

3) The lower reach of Blue Creek extends from Blue Creek's confluence with Oyachen Creek to Lake Roosevelt. This lower reach has a relatively gradual gradient compared to the upper and middle reaches, which slows the stream flow, results in depositional areas, and makes the reach more appealing to beavers (as evidenced by small beaver ponds throughout its length).

Two key observations noted during the March 8 and 9 reconnaissance include:

- Lower Blue Creek does not exhibit characteristics of flood-stage flows (i.e., there was no evidence of un-vegetated over-bank sediment deposits, erosion, scouring, or perched woody debris).
- Sediments within the creek channel are minor and any depositional areas within the channel are small (average 5 cubic feet or less), comprised mostly of silt and sand-size particles. The exception to this are areas immediately up-stream of the beaver dams.

Some of these small deposits are shown in photos in Appendix A (e.g., photo IDs 22 and 31). The majority of the unconsolidated materials observed on the creek bottom are gravel, cobble, and boulder-sized material.

Other reconnaissance findings are discussed below for each of the three reaches of lower Blue Creek. **Figures 3** and **4** depict the locations observed along Blue Creek and measurements taken at these locations are summarized in **Tables 1** through **3**. A predetermined approach for measuring key parameters at transects was not utilized in the field and the reference to field measurements being collected "every 500 meters" (see CH2MHill, 2015) was an estimate made in the field when speaking with the CH2M Hill representative. Photographs and field notes accompanying this section are presented in Appendices A and B, respectively.

3.1 UPPER REACH

As shown on **Figure 6**, the upper reach of lower Blue Creek extends approximately 1.13 miles from the confluence of the Midnite Mine Eastern Drainage with lower Blue Creek to where Blue Creek becomes more incised and confined within its channel corridor. The elevation of this upper reach drops from 2,090 feet amsl to 1,830 feet amsl with an average gradient of 4.4 percent.

The stream in the upper reach consists of pool and riffle stream types and is more heavily wooded than the other reaches. The stream bed is mostly incised and the riffle and run segments contain primarily gravel- to boulder-sized material with minimal sand to silt-sized material observed. The upper reach contains two prominent beaver dams and associated ponds, and a complex of six smaller beaver dams and ponds located downstream from the prominent beaver dams. These ponds, especially the upper two ponds, represent the most significant areas of sedimentation observed in any of the three reaches.

The uppermost beaver dam (location U-J on **Figure 3**) is approximately 27.8 feet across and four feet high. The pond behind it was on average 75 feet long and 1,819 square feet in areal extent as determined with GPS measurements. Sediment depth measurements were made by the DNR at four locations (locations U-JS-1 through U-JS-4) in the pond and thickness ranged from 7 inches to 1 foot. Sediment volume within the pond is estimated to be 1,332 cubic feet (see **Table 1**). The beaver dam itself appears relatively old as evidenced by the grass, sedge and willow vegetation community growing on it. This vegetation is thick enough to make it difficult to see the underlying wood used to construct the dam.

The second beaver dam and pond located downstream (location U-I on **Figure 3**) is larger than the uppermost pond. This dam is approximately 41.3 feet across and 3.8 feet high. The pond behind it was on average 55 feet long and 2,389 square feet in areal extent. Sediment depth measurements were made by the DNR at four locations (locations U-IS-1 through U-IS-4) in the pond and thickness ranged from 5 inches to 8.5 inches. Sediment volume within the pond is estimated to be 1,368 cubic feet (see **Table 1**). The beaver dam does not have a vegetation community growing on it, although it appears to have been in existence for a relatively long period of time.

Below the two largest beaver dams is a complex of six small beaver dams that were identified and measured. These dams are identified on **Figure 3** as locations U-B through U-G and have an average pond depth of 2.7 feet. Thin deposits of silty/sandy sediment were observed in some of these pools. These lower, much smaller dams also appear to be relatively recent compared to the two larger, older upstream dams.

3.2 MIDDLE REACH

The middle reach extends approximately 1.17 miles from the lower end of the upper reach at an elevation of 1,830 feet amsl, to the confluence of Oyachen Creek at an elevation of 1,530 feet amsl (see **Figure 6**). Average gradient of the middle reach is approximately 4.9 percent. When compared to the upper reach, this middle reach is characterized by a prominent change in geomorphic setting. Specifically, the associated valley walls are narrow and confine the channel. The creek in this middle reach is oriented more north-south compared to the lower reach, and is deeply incised in its channel (3-5 feet).

No beaver dams or ponds were observed in this middle reach from the vantage points along Blue Creek Road, although the entire channel was not observable because of thick vegetation. Note that as discussed in Section 2.1, the middle reach only was observed from the road during the field reconnaissance and the streambank was not walked and no measurements were collected.

3.3 LOWER REACH

The lower reach of lower Blue Creek extends approximately 1.7 miles from its confluence with Oyachen Creek at an elevation of 1,530 feet amsl to Lake Roosevelt at an elevation of 1,286 feet amsl, and has an average gradient of 2.7 percent (see **Figure 6**). Lower Blue Creek in this

reach receives a considerable input of water from Oyachen Creek, has a flatter gradient than both the middle and upper reaches, and consists of pool and riffle stream types.

The stream banks are dominated by thick riparian shrubs and grasses (refer to photos 2 and 4 in Appendix A). The stream bed is mostly incised and channel bottom in the riffle and run segments contains primarily gravel- to boulder-sized material with some isolated deposits of sand- or silt-sized material. Where sand- and silt-sized deposits were observed outside of beaver dam deposits, these deposits were entirely within the creek channel and small (averaging 5 cubic feet or less).

In this lower reach from Oyachen Creek to Blue Creek's mouth, four apparently recent small beaver dams were observed and measured at locations L-B, L-C, L-D and L-L. These dams are much smaller than the two largest beaver ponds on the upper reach. Representatives of the DNR indicated that they have breached many lower beaver dams in the lower reach of Blue Creek to allow fish passage for spawning. In addition, during winter 2014-2015 DNR added gravel (1-1.5 inch material) to the existing stream channel to encourage spawning.

4.0 CONCEPTUAL MODEL

A conceptual model (CM) of hydrologic flow and sedimentation in the lower Blue Creek drainage was developed based on the observations and measurements collected during the lower Blue Creek reconnaissance and using knowledge of the regional geology/geomorphology (refer to **Figure 5**).

Sediment Sources. Primary sources of sediment in Blue Creek include erosion and transport of material from decomposed granites in its headwaters, Pleistocene glacial deposits in the lower Blue Creek drainage, and mass wasting from the steep adjacent slopes throughout lower Blue Creek (including debris flows into Blue Creek). During historical mining activities, it is likely that current best management practices (BMPs) were not in place to control or prevent mine-affected sediment from flowing down the Mine Drainage and into Blue Creek. However, BMPs to prevent mine-affected sediments from entering Blue Creek were implemented at Midnite Mine beginning about 1980 (EPA, 2005).

Sediment Transport and Deposition in Blue Creek. Sediment transport or deposition depends on the energy of the stream flow within Blue Creek. In higher-energy environments, such as the steeper middle reach of lower Blue Creek, sediments are entrained in the stream

flow and transported downstream in the channel. In lower-energy environments, such as in beaver ponds, sediment would fall out of suspension and be deposited in the streambed or as finer material on the flooded alluvial/colluvial benches. Sediment deposits were found either within the largest beaver ponds or in-stream behind boulders and in small pools. The in-stream deposits, where observed, were small (average 5 cubic feet or less)

Periodic flooding (e.g., following a significant rain-on-snow event) would result in transport and deposition of sediments that differs from typical non-flood flow conditions described above. In addition to entraining larger volumes and size of sediments in the increased flood flow, flooding can result in scouring of sediments from locations that were depositional during non-flood conditions (e.g., from behind beaver dams). Under these unusual conditions, sediments could be deposited outside of the stream channel in lenticular deposits on the benches immediately adjacent to the stream channel. A deposit of this nature was not observed during the site reconnaissance.

It appears that flooding of lower Blue Creek is relatively rare based on review of historical data, reconnaissance observations, and anecdotal evidence, including personal communications with Tribal members (e.g., Brian Crossley and Randy Abrahamson). A hydrograph of seasonal flow in Blue Creek from 1990 through 2007 (period of record) is shown in **Figure 7**. The plotted data are from a United State Geologic Survey (USGS) monitoring station slightly upstream of the Midnite Mine drainage (Station 12433542, USGS, 2015) confluence with lower Blue Creek. The hydrograph presented in **Figure 7** indicates typical annual high flows between 10 and 20 cubic feet per second (cfs) and a maximum measured flow in 1997 for the period of record of 65 cfs. While there is not a reference available for what flow levels constitute lower Blue Creek overtopping its banks, it is very likely the most common annual highs between 10 and 20 cfs would not result in flooding.

Flood events may be infrequent because the soils in the Blue Creek watershed generally are very sandy which allows precipitation and snowmelt to rapidly infiltrate into the soil without running off (see **Figure 5**). As a result, most of the flow in lower Blue Creek likely is derived from groundwater baseflow discharge into the creek, as depicted in the upper panel of Figure 5, as opposed to sediment-entrained spring and storm surface runoff. The consequences of this are that Lower Blue Creek does not carry sediment during normal flows, and therefore major sediment transport primarily occurs during the infrequent large events (e.g., rain on snow events). However, while most of the volume of flow may occur from groundwater, storm runoff

events occur every year or two, and the USGS gage record shows there were about 10 flash flood peaks (clearly the result of storms) in about 17 years (see Figure 7). This information suggests that small and moderate-sized storm events can cause surface runoff depending on the season and possibly sediment transport in Blue Creek, but not necessarily overtopping of the lowest Blue Creek bench.

Locations of Sediment in Lower Blue Creek. Sediments are primarily located in the following locations based on observations made during the March 2015 reconnaissance and professional judgment:

- Localized deposits that have accumulated primarily behind the older beaver dams in the upper reach and to a much lesser extent behind the transient, much smaller beaver dams in the lower reach.
- Lens-like fluvial deposits on the adjacent benches deposited in the upper and lower reaches during rare flood events.
- Blue Creek delta where the bulk of sediment entrained in Blue Creek flow eventually is deposited.

During the two-day field effort, it was not possible to collect sufficient data to quantify estimated volumes of sediments in the bench deposits. No samples were collected during the March 2015 reconnaissance to confirm the presence or absence of sediment concentrations in excess of cleanup levels.

5.0 RECOMMENDATIONS

The following recommendations are presented to support the Selected Remedy and revisions to the *Blue Creek and Delta Assessment Work Plan* (MWH, 2011). These recommendations are based on the observations and measurements from the lower Blue Creek reconnaissance, the resulting CM, and discussion among the Tribe, Newmont, and EPA.

- Sediment sampling should be considered behind the two largest and oldest beaver dams in the upper reach near the outfall of the Midnite Mine Drainage (U-J and U-I; see Figure 3).
- Sediment sampling results and the estimated sediment quantities behind the largest two beaver dams in the upper reach could be used to evaluate efficacy of focused sediment removal at these locations, if warranted.

- Evaluation of the *Work Plan* to determine if various stream environments within the creek (i.e., pool, riffle, run) are being sampled and, if they are not, sample locations should be moved or added in representative areas to include these environments.
- Additional composite sediment sampling locations should be considered in representative areas on the benches immediately adjacent to the stream channel to determine if sediments are present on these benches in excess of the cleanup levels. These activities likely should be conducted as part of the baseline sampling round for the monitored natural recovery study for the lower Blue Creek.

6.0 REFERENCES

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MWH, 2011. Blue Creek and Delta Assessment Work Plan. Prepared for Newmont USA Limited. October.

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MWH, 2015c. Blue Creek Geomorphology. March 12 and 17, 2015. [see Appendix C]

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Accessed 1 July 2015.

FIGURES

Drawn by D. Severson

5 July 2015

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N

W E

S

0 1,000 2,000

Feet

MIDNITE MINE

Western Drainage

Central Drainage

Eastern Drainage

Turtle Lake

Blue Creek

Confluence of Mine Drainage and Blue Creek

Ford-Wellpinit Road

UPPER REACH

MIDDLE REACH

LOWER REACH

Oyachen Creek

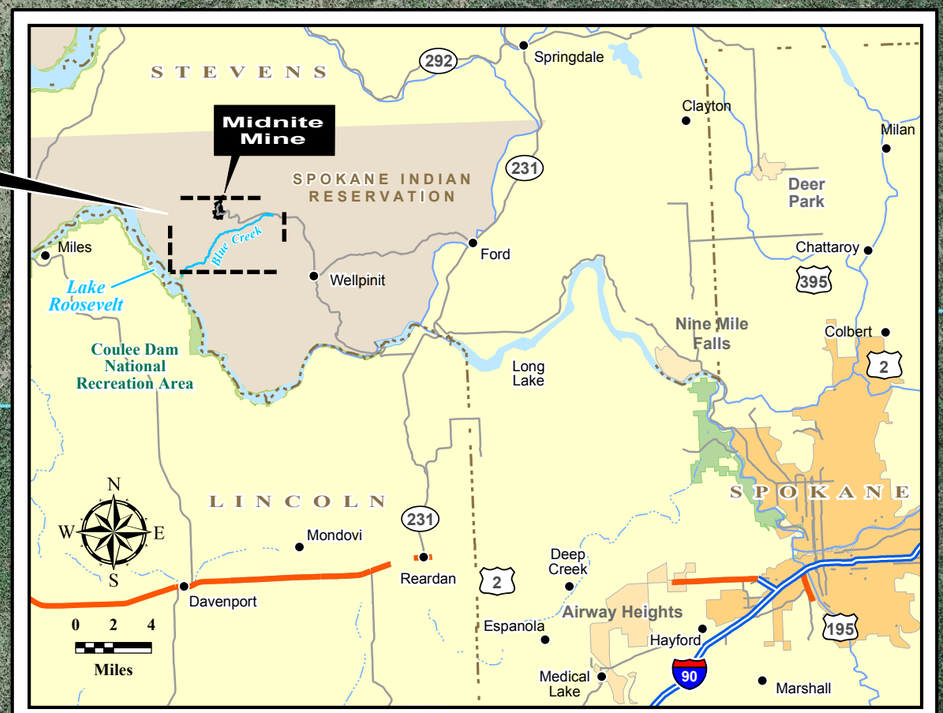
Blue Creek

Blue Creek Delta

Lake Roosevelt

MWH

MAP AREA



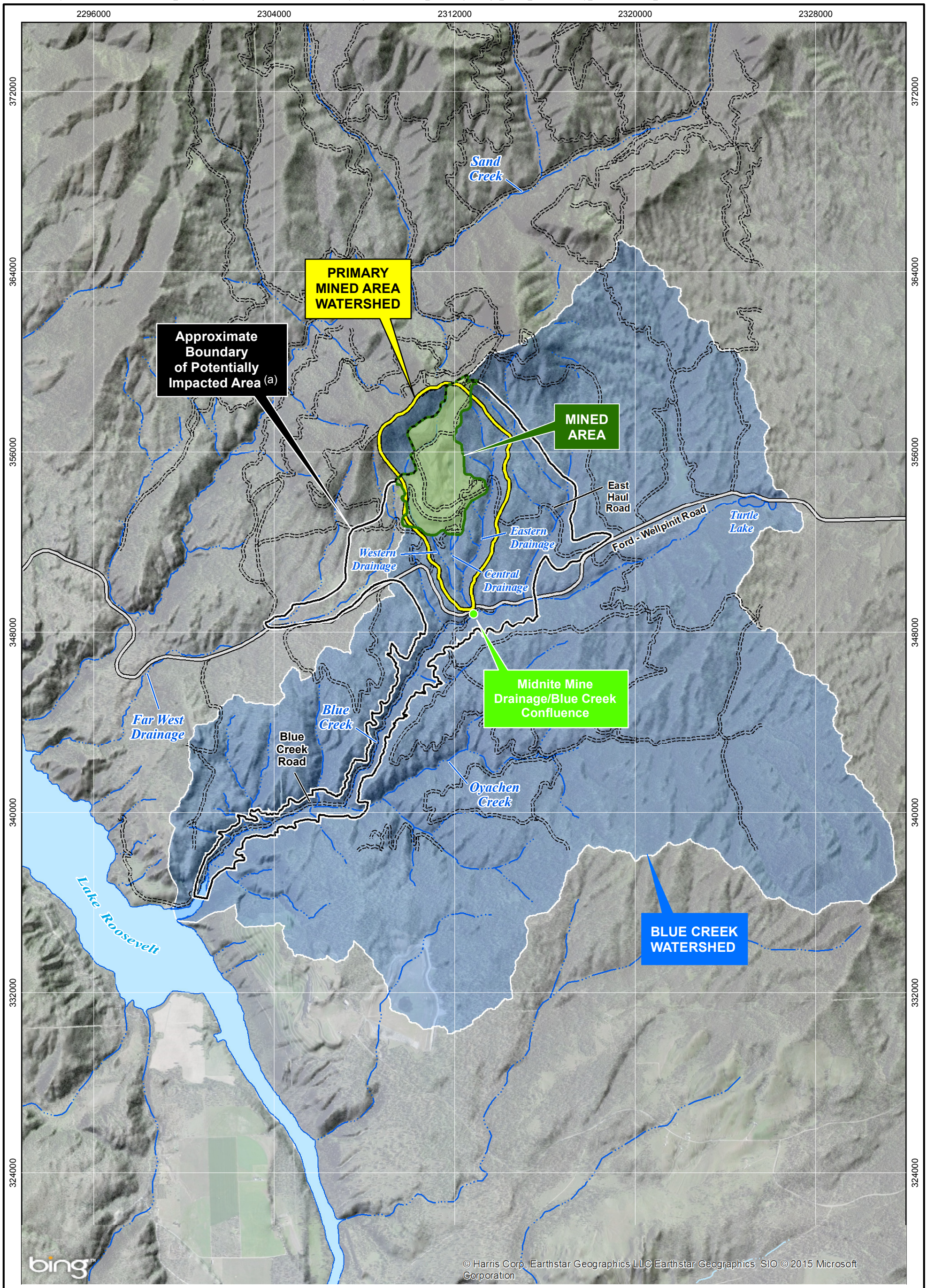
Midnite Mine

SITE AREA AND LOWER BLUE CREEK

Lower Blue Creek Sediment Recon
Spring 2015

FIGURE 1

J:\Industrial Projects\MIDNITE MINE\Deliverables_Working Documents\Blue Creek Sediment Recon Spring 2015\Final Memo_ REV 1\Figures\Fig 2_Midnite_Water Shed Map_hillshadewithaerial_Jul2015.mxd 5 July 2015 DRAWN BY D. Severson



N W E S

0 2000 4000
Feet

Paved road
Dirt road or trail
Existing drainage

(a) *SOURCE: Midnite Mine Record of Decision (EPA, 2006)*

MWH

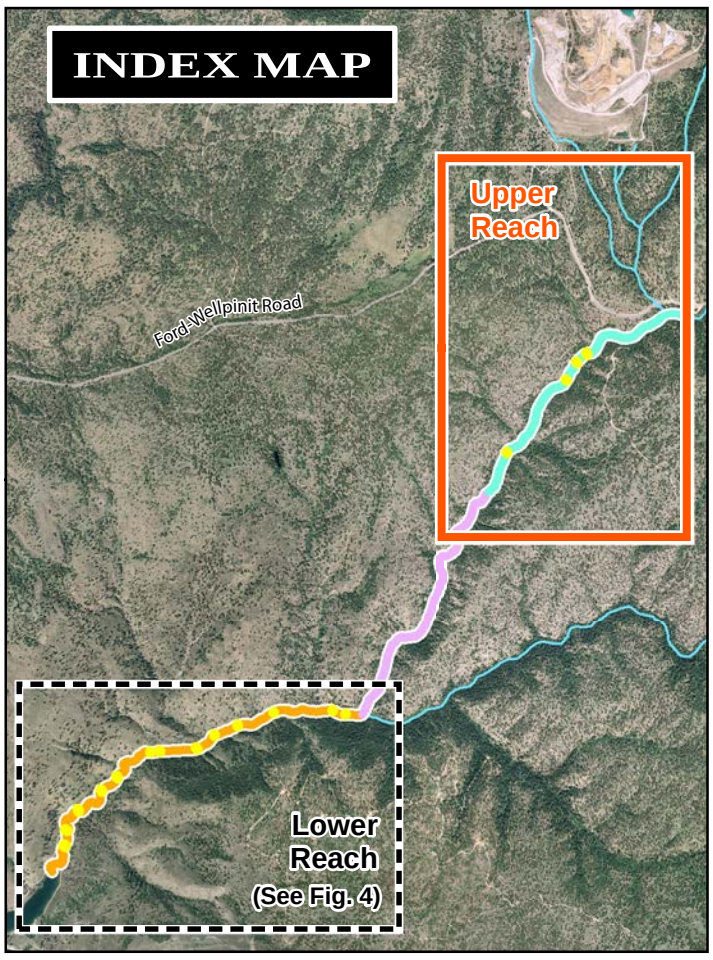
Midnite Mine

BLUE CREEK WATERSHED MAP

Lower Blue Creek Sediment Recon Spring 2015

FIGURE 2

INDEX MAP



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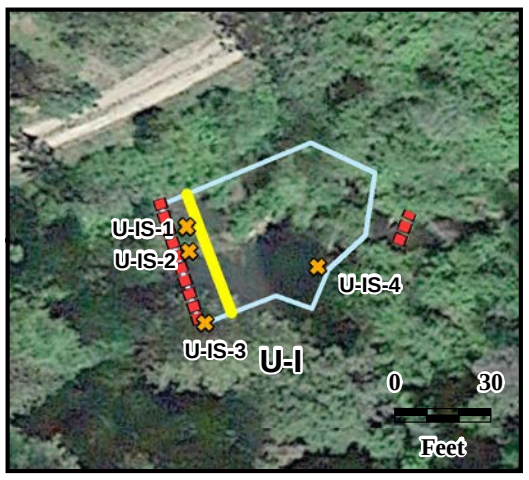

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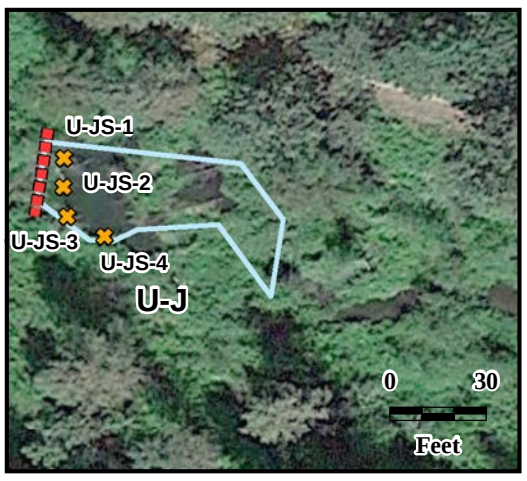
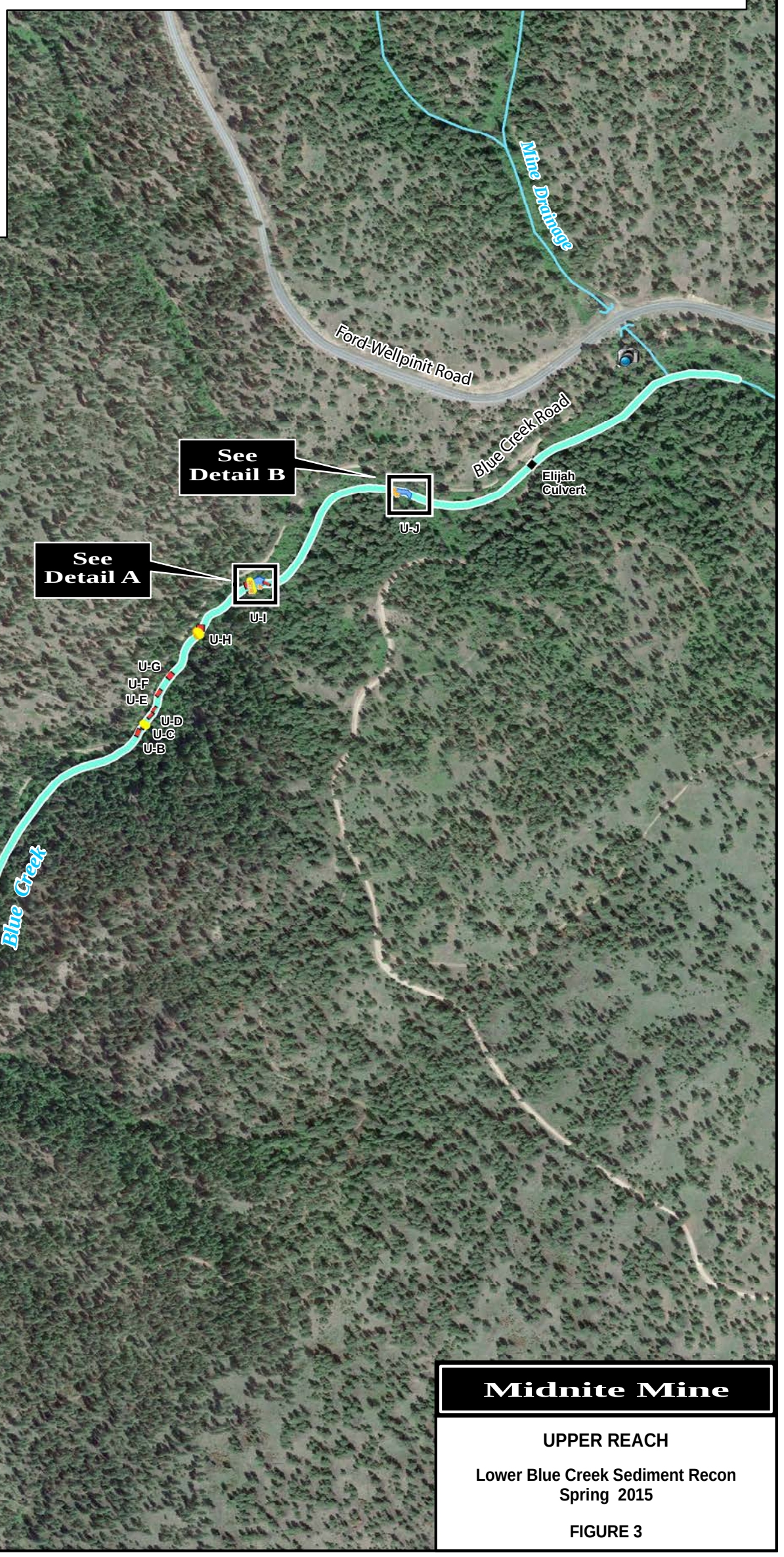


EXPLANATION

- Beaver pond sediment thickness measurement location
- Fish recording station
- Photopoint
- Stream gauge
- Beaver dam
- Culvert
- Profile transect
- Beaver dam pool
- Upper reach
- Middle reach
- Lower reach
- U-A to U-J — Observation locations



MWH

Midnite Mine

UPPER REACH

Lower Blue Creek Sediment Recon
Spring 2015

FIGURE 3

EXPLANATION

- Fish recording station
- Photopoint
- Stream gauge
- Beaver dam
- Culvert
- Profile transect
- Beaver dam pool
- Upper reach
- Middle reach
- Lower reach
- L-A to L-M — Observation locations

N W E S

0 250 500
Feet

Blue Creek Road

Blue Creek

Oyachen Creek

Lake Roosevelt

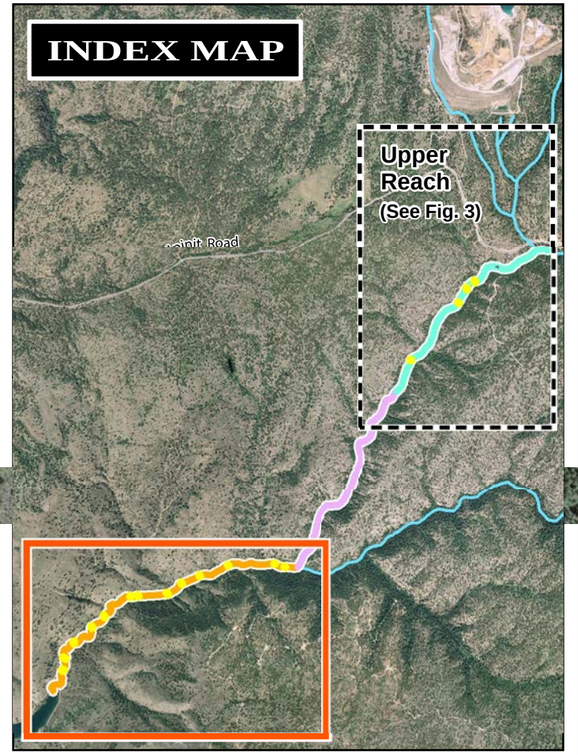
L-A L-B L-C L-D L-E L-F L-G L-H L-I L-J L-K L-L L-M

See Detail A

DETAIL A
Typical Station

0 50 100
Feet

INDEX MAP



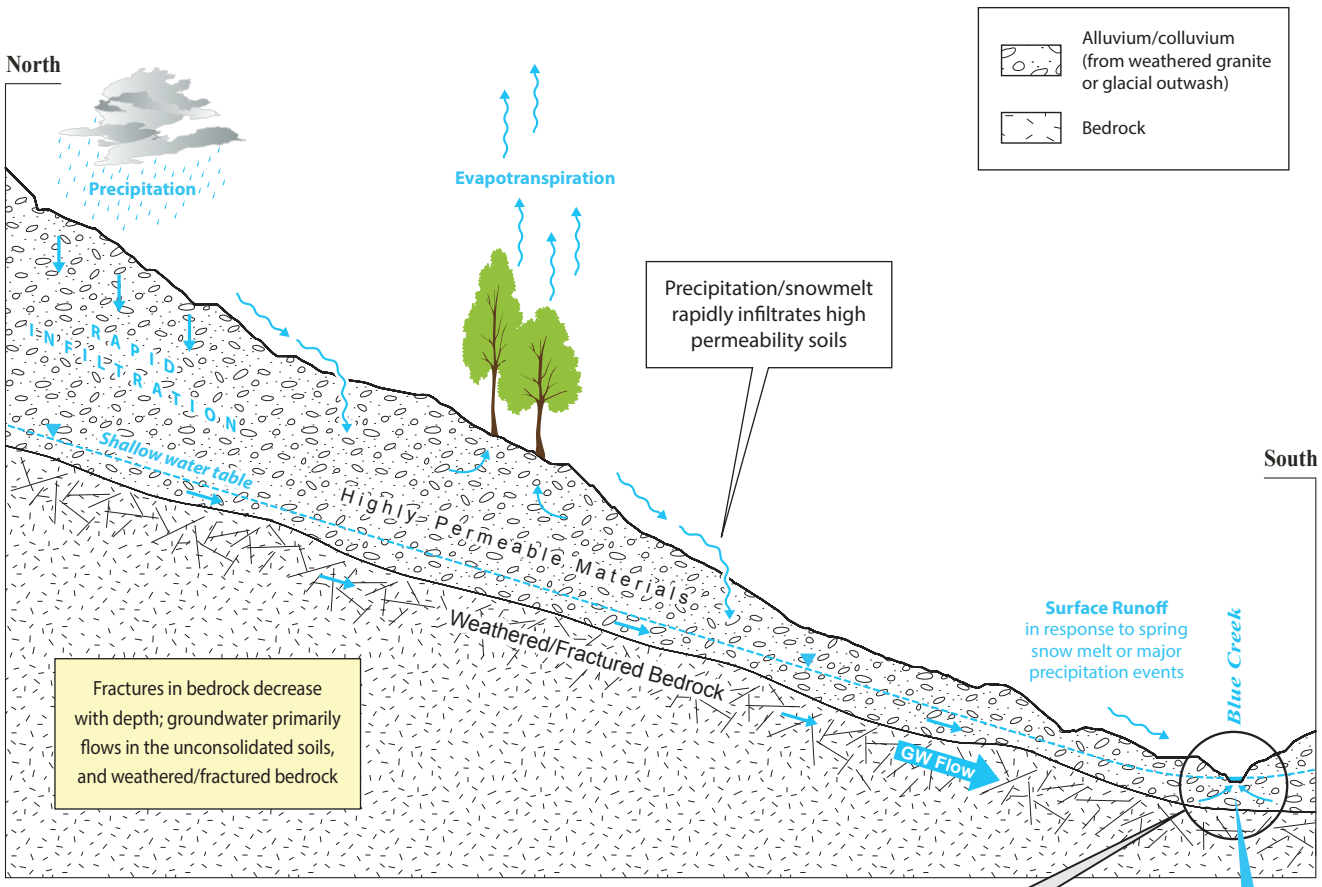
MWH

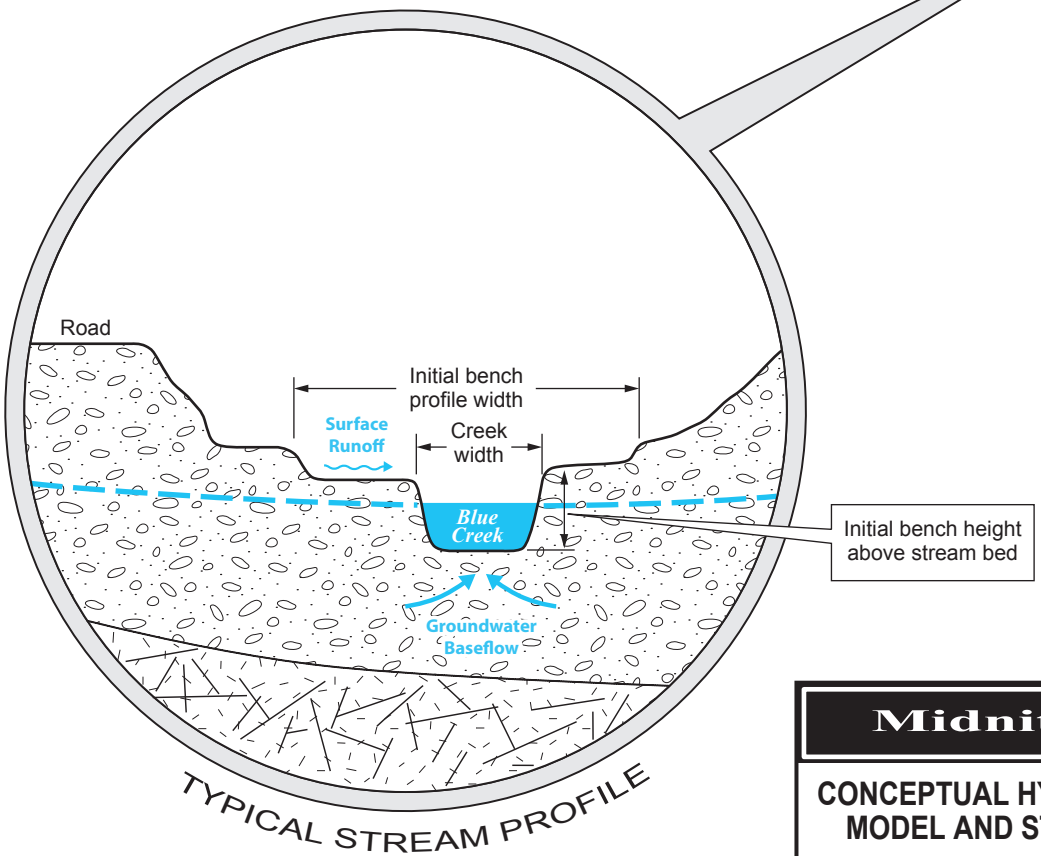
Midnite Mine

LOWER REACH

Lower Blue Creek Sediment Recon
Spring 2015

FIGURE 4





MWH

Midnite Mine

CONCEPTUAL HYDROLOGIC FLOW MODEL AND STREAM PROFILE

Lower Blue Creek Sediment Recon
Spring 2015

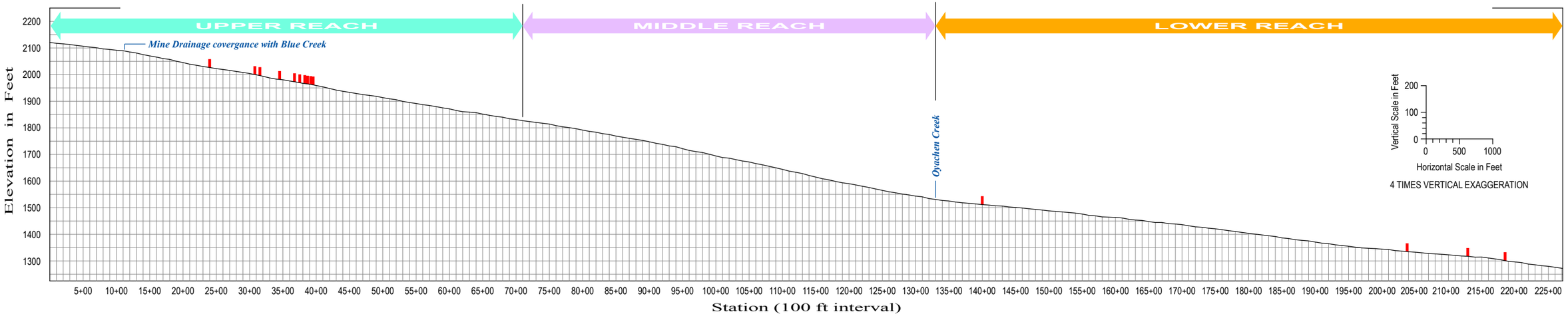
FIGURE 5

DRAWN BY D. Severson

5 July 2015

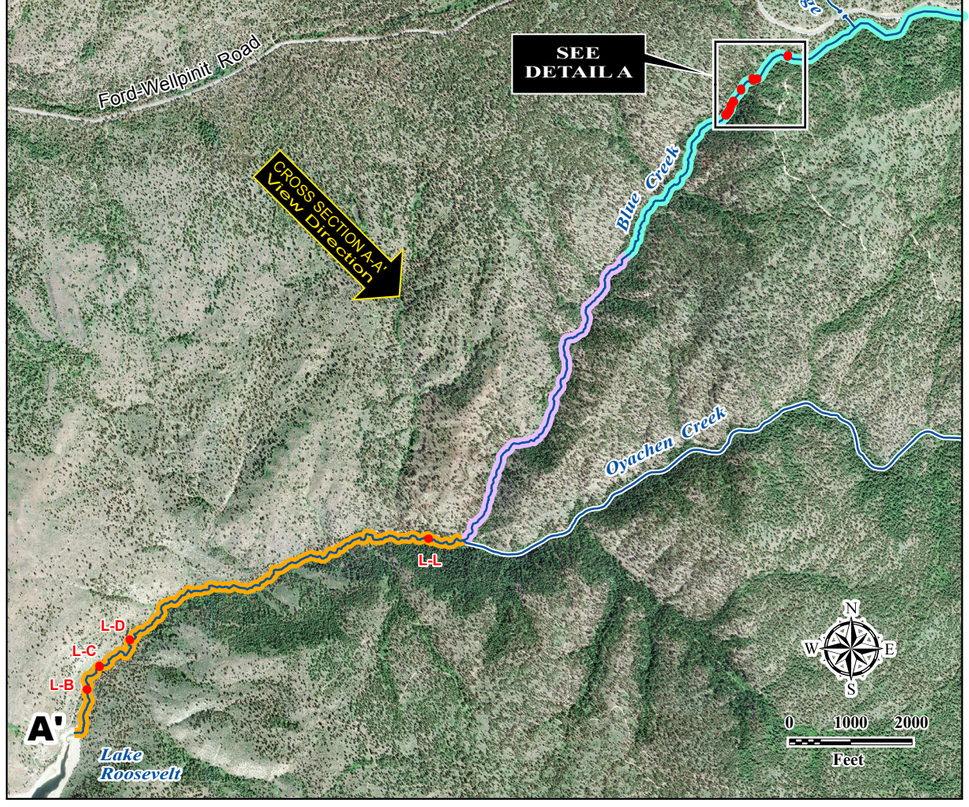
J:\Industrial Projects\MIDNITE MINE\Deliverables_Working Documents\Blue Creek Sediment Recon Spring 2015\Final Memo_ REV 1\Figures\Fig 6_Lower Blue Creek Elevation Profile A-A'_2Jul2015.ai

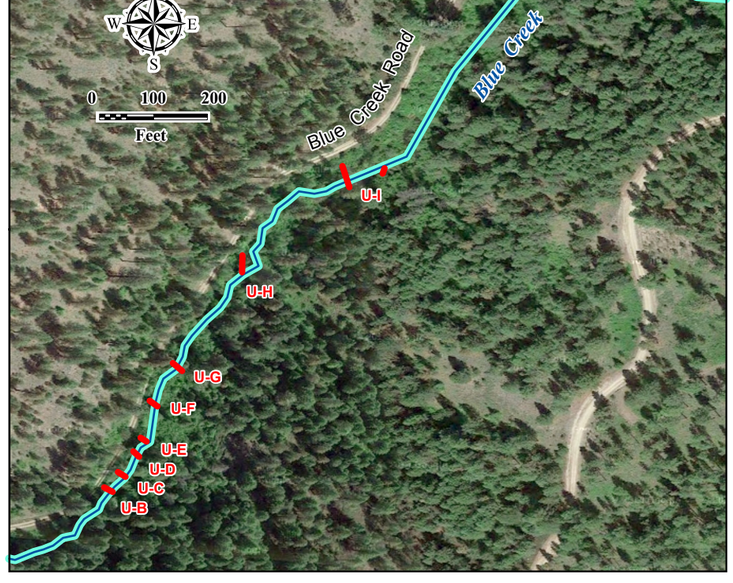
A Northeast — **LOOKING SOUTHEAST** — **A'** Southwest



EXPLANATION

- Upper reach (data collected)
- Middle reach (no data collected)
- Lower reach (data collected)
- Beaver dam



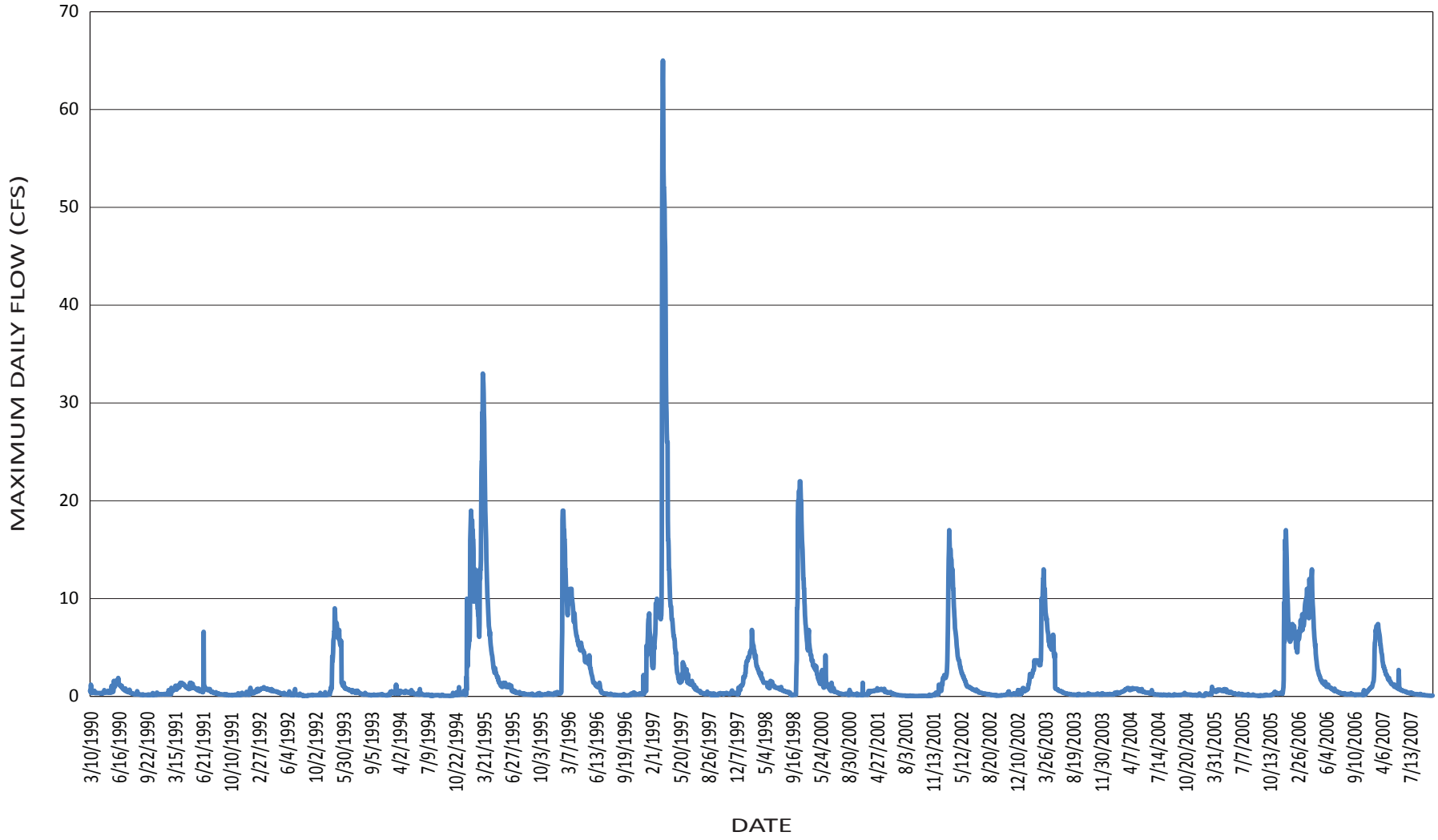


MWH

Midnite Mine

LOWER BLUE CREEK ELEVATION PROFILE A-A'
Lower Blue Creek Sediment Recon Spring 2015

FIGURE 6



MWH

NOTE:
Data provided by USGS
(http://waterdata.usgs.gov/wa/nwis/inventory/?site_no=12433542&agency_cd=USGS),
continuous data available only through 2007.

Midnite Mine

BLUE CREEK
HISTORICAL FLOW HYDROGRAPH

Lower Blue Creek Sediment Recon
Spring 2015

FIGURE 7

TABLES

TABLE 1
SUMMARY OF LOWER BLUE CREEK
BEAVER DAM AND BEAVER POND MEASUREMENTS

Reach	Creek Mile[1]	Location ID	Location Type	Dam Height (feet)	Pond Length (feet)	Pond Width (feet)	Pond Area[2] (sq. feet)	Sediment Thickness Measurement (feet)	Estimated Sediment Volume within Pond[3] (cubic feet)	Observations
Two Largest Beaver Dams/Ponds Measurements - Upper Reach										
Upper Reach	0.24	U-J	Beaver Dam/Pool	4.0	75.0	27.8	1,819	--	1,332	The uppermost and second largest beaver pond. The dam is heavily vegetated. Sediment depth measurements were made within this pond to estimate sediment volume on the pond bottom.
	--	U-JS-1	Sediment Measurement	--	--	--	--	0.63		
	--	U-JS-2	Sediment Measurement	--	--	--	--	0.67		
	--	U-JS-3	Sediment Measurement	--	--	--	--	0.63		
	--	U-JS-4	Sediment Measurement	--	--	--	--	1.00		
	0.38	U-I	Beaver Dam/Pool	3.8	55.0	41.3	2,389	--	1,368	The lower of the two uppermost beaver ponds. Sediment depth measurements were made within this pond to estimate sediment volume on the pond bottom
	--	U-IS-1	Sediment Measurement	--	--	--	--	0.71		
	--	U-IS-2	Sediment Measurement	--	--	--	--	0.58		
	--	U-IS-3	Sediment Measurement	--	--	--	--	0.42		
	--	U-IS-4	Sediment Measurement	--	--	--	--	0.58		
Other Beaver Dam Measurements										
Upper Reach	0.37	U-I	Beaver Dam	--	--	10.5	--	--	--	A small beaver dam immediately upstream from the primary pond at U-I.
	0.44	U-H	Beaver Dam	--	--	31.3	--	--	--	Medium size beaver dam part of six-dam complex.
	0.48	U-G	Beaver Dam	5	--	22.5	--	--	--	Beaver dams part of a six-dam complex in the upper reach.
	0.49	U-F	Beaver Dam	3.8	--	17.8	--	--	--	
	0.51	U-E	Beaver Dam	1.8	--	13.1	--	--	--	
	0.515	U-D	Beaver Dam	2.5	--	14.7	--	--	--	
	0.523	U-C	Beaver Dam	--	--	16.5	--	--	--	Beaver dam part of a six-dam complex in the upper reach. Channel is deeply incised into the fluvial bench deposits.
	0.53	U-B	Beaver Dam	2.8	--	17.9	--	--	--	Beaver dam part of a six-dam complex in the upper reach.
Lower Reach	2.31	L-L	Beaver Dam	1.5	--	8.1	--	--	--	A very small beaver dam is present at station L-L.
	3.38	L-D	Beaver Dam	--	--	12.6	--	--	--	A small beaver dam in the lower reach, near the stream gauging stilling well.
	3.53	L-C	Beaver Dam	2.28	--	19.3	--	--	--	The largest beaver dam in the lower reach.
	3.64	L-B	Beaver Dam	--	--	11.9	--	--	--	Beaver dams in the lower reach are small and apparently relatively recent.

--	No data.
1	Creek mile given is distance downstream from the Midnite Mine drainage confluence with lower Blue Creek.
2	Pond area is provided for the two (2) upper and largest beaver ponds. The estimated area was determined by GPS survey of the pond perimeter.
3	Sediment volume estimate is the (pond area)*(average(sediment thickness measurements)).
Sediment Measurement:	Refers to direct depth measurement of sediment on the bottom of a beaver pond. This was performed at pond location U-I and U-J.
Location ID:	U-J indicates a beaver dam measured in the upper reach of lower Blue Creek (refer to Figure 3 for the relative location)
	L-D indicates a beaver dam measured in the lower reach of lower Blue Creek (refer to Figure 4 for the relative location)

TABLE 2
SUMMARY OF LOWER BLUE CREEK
STREAM PROFILE MEASUREMENTS, FEATURES, AND OBSERVATIONS
(Page 1 of 2)

Reach	Location ID	Creek Mile[1]	Stream Type	Feature	Bench Thickness[2] (feet)	Total Bench Width (feet)	Creek Width (feet)	Effective Bench Width[3] (feet)	Observations
Upper Reach	Midnite Drainage Confluence	0	Riffle	Culvert	NA	13.3	--	--	The confluence of the Midnite Drainage. Midnite Drainage enters from the north via a culvert under the Wellpinit road, and passes beneath the Lower Blue Creek road in another culvert to join Lower Blue Creek.
	Elijah Road Culvert	0.13	Riffle	Culvert	NA	31.4	--	--	A large, 72 inch diameter culvert passes Lower Blue Creek beneath the Elijah cut-off road.
	U-I	0.38	Pool	Profile	--	39.5	--	--	This profile is a measurement of the beaver pond width.
	U-H	0.44	Pool	Log Weir	--	14.8	--		One of several man-made log weirs in the upper reach built in the 1990s. The channel is deeply incised.
	U-H	0.44	Run	Profile	--	29.1	--	--	Run/Riffle stream type. The channel is deeply incised, the banks are very vegetated.
	U-C	0.52	Riffle	Profile	1.1	15.6	--	--	Channel is deeply incised into the fluvial bench deposits.
	U-A	0.91	Run	Profile	1.2	10.9	5.8	5.1	Run/Riffle stream type. The channel is deeply incised, the banks are very vegetated.
Middle Reach	M-A	2.02	Riffle	Photo only	NA	--	--		No data were collected in the middle reach. This location is a photo location from the road, photos are shown in Appendix A.
Lower Reach	L-M	2.25	Run	Profile	1.4	12.3	6.7	5.6	Run stream type. Small amounts of sand sized particle sediment is present in the stream bottom.
	L-M	2.25	Riffle	Fish Station	NA	--	--	--	The location of an active fish counting station operated by the Tribe.
	L-L	2.31	Riffle	Profile	1	19.0	8.0	11.0	Riffle stream type. Typical stream bottom composition for riffle/run reaches in the lower reach is observed here. Very small deposits of sand and silt-sized material are visible among the gravel and cobbles.

TABLE 2
SUMMARY OF LOWER BLUE CREEK
STREAM PROFILE MEASUREMENTS, FEATURES, AND OBSERVATIONS
(Page 2 of 2)

Reach	Location ID	Creek Mile[1]	Stream Type	Feature	Bench Thickness[2] (feet)	Total Bench Width (feet)	Creek Width (feet)	Effective Bench Width[3] (feet)	Observations
Lower Reach (Cont.)	L-K	2.56	Riffle	Profile	1.3	12.5	6.0	6.5	Channel is deeply incised into the fluvial bench deposits.
	L-J	2.72	Riffle	Profile	1.2	23.8	8.3	15.5	Riffle/Pool stream type, the person shown in the photo in Appendix A is standing on the primary fluvial bench deposits.
	L-I	2.82	Riffle	Profile	1.7	27.9	8.4	19.5	Pool stream type. Stream bottom composition of gravel with sand-sized sediment.
	L-H	2.91	Riffle	Profile	1.4	57.0	9.0	48.0	Fluvial bench deposits are vegetated with rushes, grasses, forbs and shrubs.
	L-G	3.06	Pool	Profile	--	30.5	--	--	This profile is a measurement of the beaver pond width.
	L-F	3.10	Riffle	Profile	1.6	20.6	7.5	13.1	Riffle stream type. The fluvial bench is dominated by rushes and grasses.
	L-E	3.29	Riffle	Profile	1.2	42.1	6.5	35.6	Fluvial bench deposits are vegetated with rushes, grasses, forbs and shrubs.
	L-D	3.38	Pool	Profile	1.4	39.2	9.7	29.5	Fluvial bench deposits are vegetated with rushes, grasses, forbs and shrubs.
	L-D	3.38	Riffle	Stream Gauge	--	--	--	--	Gauge at 0.30 feet on this day at 1041 am.
	L-C	3.53	Pool	Profile	2.28	54.7	11.0	43.7	The channel is deeply incised, the banks are very vegetated.
	L-B	3.64	Pool	Profile	1.1	66.0	--	--	This profile crosses a beaver pond. The creek width was not measureable.
	L-A	3.71	Riffle	Profile	2.2	32.7	--	--	The creek at this location is a riffle stream type with large boulders.
	L-A	3.71	Riffle	Profile	--	32.0	--	--	

-- No data.
1 Creek mile given is distance downstream from the Midnite Mine drainage confluence with lower Blue Creek.
2 Bench thickness measured from creek bottom to the level of the alluvial bench using a stadia rod and laser level.
3 The total of bench widths on either side of the creek at a given profile location. Calculated as total bench width minus creek width.
Profile: A GPS line measured perpendicular to the creek channel containing the total width of the initial (adjacent) alluvial/colluvial bench at that location
Location ID: U-H indicates a stream profile measured in the upper reach of lower Blue Creek (refer to Figure 3 for the relative location)
L-E indicates a stream profile measured in the lower reach of lower Blue Creek (refer to Figure 4 for the relative location)

TABLE 3
SUMMARY OF LOWER BLUE CREEK
UPPER, MIDDLE, AND LOWER REACH PHYSICAL CHARACTERISTICS

Reach of Lower Blue Creek	Creek Length (miles)	Elevation Change (feet amsl)	Elevation Change (feet)	Gradient (percent)	Number of Beaver Dams Measured	Estimated Number of Beaver Dams in Reach[1]	Estimated Sediment Behind Beaver Dams in Reach[2] (cubic meters)	Number of Bench Transects
Upper	1.13	2,090 - 1,830	260	4.4	10	10	76.5	4
Middle	1.17	1,830 - 1,530	300	4.9	--	--	--	--
Lower	1.7	1,530 - 1,286	244	2.7	4	12	na	12

-- No data.

amsl Feet above mean sea level, NGVD 1929.

na Not available to be calculated.

1 The upper and lower reaches of lower Blue Creek are mostly observable from the road. All observed beaver dams were measured in the upper reach. However, several small beaver dams were observed in the lower reach and were not measured.

2 The sediment volume estimates include only the two upper and largest beaver dams U-I and U-J (where sediment depth was measured).

APPENDIX A

SITE RECONNAISSANCE PHOTO LOG

MWH

Photographic Log

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 1 **Photo Location:** Upper Reach, Station U-A, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle/Pool stream type	
Photograph ID: 2 **Photo Location:** Upper Reach, Station U-B, Beaver Dam **Direction:** **Survey Date:** 3/9/2015 **Comments:** Beaver dam part of a six-dam complex in the upper reach.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 3	
Photo Location: Upper Reach, Station U-C, Beaver Dam	
Direction:	
Survey Date: 3/8/2015	
Comments: Beaver dam part of a six-dam complex in the upper reach.	

Photograph ID: 4	
Photo Location: Upper Reach, Station U-C, Profile 1	
Direction:	
Survey Date: 3/8/2015	
Comments: Channel is deeply incised into the fluvial bench deposits.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 5	
Photo Location: Upper Reach, Station U-D, Beaver Dam	
Direction:	
Survey Date: 3/9/2015	
Comments: Beaver dam part of a six-dam complex in the upper reach.	

Photograph ID: 6	
Photo Location: Upper Reach, Station U-F, Beaver Dam	
Direction:	
Survey Date: 3/9/2015	
Comments: Beaver dam part of a six-dam complex in the upper reach.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 7 **Photo Location:** Upper Reach, Station U-G, Beaver Dam **Direction:** **Survey Date:** 3/9/2015 **Comments:** Beaver dam part of a six-dam complex in the upper reach.	
Photograph ID: 8 **Photo Location:** Upper Reach, Station U-H, Beaver Dam **Direction:** **Survey Date:** 3/8/2015 **Comments:** Medium size beaver dam and pool are shown.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 9 **Photo Location:** Upper Reach, Station U-H, Log Weir **Direction:** **Survey Date:** 3/8/2015 **Comments:** One of several man-made log weirs in the upper reach.	
Photograph ID: 10 **Photo Location:** Upper Reach, Station U-H, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Channel is deeply incised into the fluvial bench deposits.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 11 **Photo Location:** Upper Reach, Station U-I, Beaver Dam **Direction:** **Survey Date:** 3/8/2015 **Comments:** The lower of the two uppermost and largest beaver dams.	
Photograph ID: 12 **Photo Location:** Upper Reach, Station U-I, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** The lower of the two uppermost and largest beaver ponds.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 13 **Photo Location:** Upper Reach, Station U-J, Beaver Dam **Direction:** **Survey Date:** 3/9/2015 **Comments:** Uppermost beaver dam. The dam is heavily vegetated.	
Photograph ID: 14 **Photo Location:** Upper Reach, Station U-J, Beaver Dam **Direction:** **Survey Date:** 3/9/2015 **Comments:** The uppermost and second largest beaver dam observed.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 15	
Photo Location: Upper Reach, the Culvert beneath the Elijah Road	
Direction:	
Survey Date: 3/8/2015	
Comments: Approximately 72 inch diameter culvert.	

Photograph ID: 16	
Photo Location: Middle Reach, Station M-A	
Direction:	
Survey Date: 3/9/2015	
Comments: Lookind down approximately 30 feet to Blue Creek from road. The creek is steep in this reach and depositional areas or beaver dams are not observed.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 17	
Photo Location: Lower Reach, Station L-A, Profile 1	
Direction:	
Survey Date: 3/8/2015	
Comments: The creek at this location is a riffle stream type with large boulders.	

Photograph ID: 18	
Photo Location: Lower Reach, Station L-A	
Direction:	
Survey Date: 3/8/2015	
Comments: The creek at this location is a riffle stream type with large boulders.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 19	
Photo Location: Lower Reach, Station L-A, Profile 2	
Direction:	
Survey Date: 3/8/2015	
Comments: The creek at this location is a riffle stream type with large boulders.	

Photograph ID: 20	
Photo Location: Lower Reach, Station L-B, Beaver Dam	
Direction:	
Survey Date: 3/8/2015	
Comments: Beaver dams in the lower reach are small and apparently relatively recent.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 21 **Photo Location:** Lower Reach, Station L-B **Direction:** **Survey Date:** 3/8/2015 **Comments:** Depositional area created by beaver dam.	
Photograph ID: 22 **Photo Location:** Lower Reach, Station L-C, Beaver Pond **Direction:** **Survey Date:** 3/9/2015 **Comments:** View of a larger beaver pond in the lower reach.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 23	
Photo Location: Lower Reach, Station L-C, Beaver Dam	
Direction:	
Survey Date: 3/8/2015	
Comments: Beaver dams in the lower reach are small and apparently relatively recent.	

Photograph ID: 24	
Photo Location: Lower Reach, Station L-C, Profile 1	
Direction:	
Survey Date: 3/8/2015	
Comments: Beaver dams in the lower reach are small and apparently relatively recent.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 25	
Photo Location: Lower Reach, Station L-D, Beaver Dam	
Direction:	
Survey Date: 3/8/2015	
Comments:	

Photograph ID: 26	
Photo Location: Lower Reach, Station L-D, Profile 1	
Direction:	
Survey Date: 3/8/2015	
Comments: Fluvial bench deposits are typically vegetated with rushes, grasses, forbs and shrubs.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 27 **Photo Location:** Lower Reach, Station L-D, Stream Gauging Station **Direction:** **Survey Date:** 3/8/2015 **Comments:** Gauge at 0.30 feet on this day at 1041.	
Photograph ID: 28 **Photo Location:** Lower Reach, Station L-E, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle stream type at this profile location.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 29

Photo Location:
Lower Reach, Station L-E

Direction:

Survey Date:
3/8/2015

Comments:
This photo shows the typical condition of the primary fluvial bench which exists 1-3 feet above the creek bottom and is heavily vegetated.

Photograph ID: 30

Photo Location:
Lower Reach, Station L-E, Gravel

Direction:

Survey Date:
3/9/2015

Comments:
Gravel added by the Tribe DNR to support spawning.

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 31 **Photo Location:** Lower Reach, Station L-F, Profile **Direction:** **Survey Date:** 3/9/2015 **Comments:** Stadia rod and laser level shown used to measure fluvial bench deposit thickness.	
Photograph ID: 32 **Photo Location:** Lower Reach, Station L-F **Direction:** **Survey Date:** 3/9/2015 **Comments:** Pool stream type, the person shown is standing on the primary fluvial bench deposits.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 33 **Photo Location:** Lower Reach, Station L-G, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Pool stream type, the person shown is standing on the primary fluvial bench deposits.	
Photograph ID: 34 **Photo Location:** Lower Reach, Station L-H, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle stream type	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 35 **Photo Location:** Lower Reach, Station L-I **Direction:** **Survey Date:** 3/9/2015 **Comments:** Stream bottom composition of gravel with sand-sized sediment.	
Photograph ID: 36 **Photo Location:** Lower Reach, Station L-I **Direction:** **Survey Date:** 3/9/2015 **Comments:** Photo shows a typical mid-stream sand-sized particle sediment deposit, approximately 1 cubic foot volume.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 37 **Photo Location:** Lower Reach, Station L-I **Direction:** **Survey Date:** 3/9/2015 **Comments:** Pool stream type. Stream bottom composition of gravel with sand-sized sediment.	
Photograph ID: 38 **Photo Location:** Lower Reach, Station L-I, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle stream type	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 39	
Photo Location: Lower Reach, Station L-J, Profile 1	
Direction:	
Survey Date: 3/8/2015	
Comments: Riffle/Pool stream type, the person shown is standing on the primary fluvial bench deposits.	

Photograph ID: 40	
Photo Location: Lower Reach, Station L-K, Profile	
Direction:	
Survey Date: 3/9/2015	
Comments: Channel is deeply incised into the fluvial bench deposits.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 41 **Photo Location:** Lower Reach, Station L-L **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle stream type. Typical very small deposits of sand and silt-sized material are visible among the gravel and cobbles.	
Photograph ID: 42 **Photo Location:** Lower Reach, Station L-L, Profile 1 **Direction:** **Survey Date:** 3/8/2015 **Comments:** Riffle stream type	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 43	
Photo Location: Lower Reach, Station L-L, Beaver Dam	
Direction:	
Survey Date: 3/8/2015	
Comments: Very small beaver dam is shown.	

Photograph ID: 44	
Photo Location: Lower Reach, Station L-M, Profile	
Direction:	
Survey Date: 3/9/2015	
Comments: Run stream type. Sand sized particle sediment is present in the stream bottom.	

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 45

Photo Location:
Lower Reach, Upper fish counting station near confluence with Oyachen Creek.

Direction:

Survey Date:
3/8/2015

Comments:

Photograph ID: 46

Photo Location:
Measuring the initial alluvial deposits bench thickness.

Direction:

Survey Date:
3/9/2015

Comments:
Shown are the stadia rod, laser level and GPS used during the reconnaissance.

Client:	**Newmont**	**Project:**	**Lower Blue Creek Reconnaissance**
Site Name:	**Midnite Mine**	**Site Location:**	**Lower Blue Creek**

Photograph ID: 47

Photo Location:
Lower Blue Creek at the mouth near Lake Roosevelt.

Direction:

Survey Date:
3/8/2015

Comments:
The creek at this location is a riffle stream type with large boulders.

APPENDIX B

FIELD NOTES

✓Brian Crossley Vance Drain
✓Rod Abrahamson Peter Germiss 3/8/15
(DAY 1)

830 At Blue Creek
Site A to Meet Rodney & ~~Andy~~ Brian
to recon the creek.

955 @ Lake mouth near Lake Roosevelt
Reach A
– Profile 1 at mouth

10:00am profile 2 – ~60' upstream
from Profile 1

10:08 Site B – Beaver dam 1

10:18 Site C – (1¼ mile up from Blue Creek
confluence w/ Lake Roosevelt)

✓ new beaver dam and profile 50' upstream

10:29 75' Site D upstream of USGS gauging
station

Profile ✓ 50' upstream of beaver dam
new profile

✓ profile 2 – ? upstream of P2

✓ profile 3 – 25'-30' wide
from P3 to Site E steep/narrow profile

Site E – no beaver dam (riffle
– thick riparian stretch)
veg cover

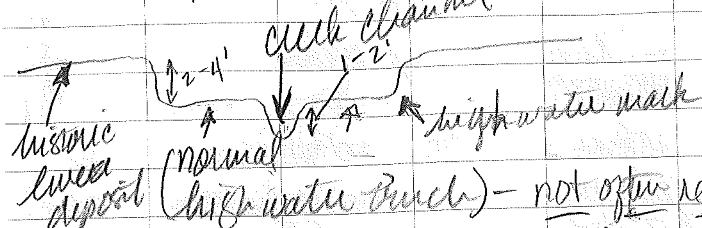
Site F – narrow width, no beaver
dam (20-30' width)

Site G – V. narrow from site F to G
(incised channel)

11:37 Site H – beaver dam present
↕ above initial profile (50' upstream)
incised channel
12:06 Site I – width of 15' – incised channel

– from Site H (below/at Ogden
Creek confluence w/ Blue Creek)
to here (Site I) very incised
channel + steep gradient

TYPICAL X-section of Blue Creek



no evidence of woody debris outside channel

12:21 Site I - 1st beaver on upper stretch, still narrow from H → I to J v. incised

12:40 Site K - log weir (sp?) (from J to K numerous beaver dams) probably installed in the 1990s

~50' upstream active beaver dam that Peter collected measurements.

12:43 Site L - v. large beaver dam - 4' high, ~45' wide

12:44 profile M upper end of Site L beaver dam

12:55 - Eliza / Blue Creek Road crossing (of Blue Creek)

3/9/15 (DAY 2 - FINAL DAY) Peter Ellisse, Vance ... Rodney Abrahamsen, Nick Eldred

8:40 Site A - 3.2' mark on rod (in creek)
- 1 foot up at measuring device
2.2' thickness of seds on bench just above creek (vegetated bench w/ scrubs / grass)

9:00 Site B
2.1 on rod
1.0 on measuring device
1.1' thickness of seds on 1st bench

9:15 Site C beaver dam
3.28' on rod
1.00 on measuring device
2.28' thickness of seds

creek width (pool) 11.0' wide

9:17 Site D – beaver dam

Profile 1
2.4
1.0
1.4 thickness of sed on initial bank (single water mark)

9.7' pool width at transect (profile 1) (photo taken)

Profile 2 – 6½' width (riffle)
2.2
1.0
1.2 (2 photos)

9:25 Profile 2A (NEW) –

2 photos taken (upstream / cross stream) – riffle section

2.6
−1.0
1.6' thick; stream width 7½' incised stream, almost no bench (natural bottom)

9:30 Site E – profile 1 (photo upstream)

2.4
−1.0
1.4' thick; 9' stream width

09:45 Site F – riffle reach (3 photos: close upstream

2.7
1.0
1.7' depth, 8.4' wide
incised channel – covered in vegetation veg

09:57 Site G
2.3 photo upstream
1.0
1.2' thickness, 8.3 width
incised stream

→ profile 2 upstream of G (2 photos)
2.3 6' wide
−1.0
1.3' thickness

Site H - profile 1 (50' downstream of beaver dam)

① 2.0'
1.0'
1.0' thickness of seds
② stream width - 8.0'

③ 18" beaver dam height

3:4" → Profile 2 - NEW just upstream of fish counter
(a) new well BCMW02

① 2.4'
-1.0
1.4
② 6.7' width
③ 6" coarse sediment depth

above Oyachen Creek - 2 photos in steep canyon
- 40' bank (vertical) of flood)

Site H - profile 3 (NEW) incised channel
beaver dam start of beaver dam above Oyachen Creek
2.8' height of beaver dam

profile 4 (Site H) - beaver dam
2.5' high

11:5 profile 5 →
3.8' beaver dam height

Reach L (NEW) - "dam 3"
① dam 4' height
② 27' wide

Site I - profile 1

① 2.2
1.0
1.2' bench height (sed depth)

② 5.8' wide (creek)

13:27 shooting edges of upper 2 large beaver ponds down below McNeil drainage confluence

APPENDIX C

RELEVANT COMMUNICATIONS

MEMORANDUM CH2MHILL

Blue Creek Geomorphology Mapping Field Visit March 9, 2015

PREPARED FOR: Elly Hale/TOPO

PREPARED BY: Daniel Malmon/CH2M HILL

DATE: March 10, 2015

On March 9, 2015, Daniel Malmon/CH2M HILL visited Blue Creek to observe reconnaissance field measurements being conducted in Blue Creek by MWH at the Midnite Mine site in Wellpinit, WA. Daniel arrived at the Spokane tribe Department of Natural Resources and met briefly with Randy Connolly, Brian Crossley, and Brian's assistant. Daniel and Brian went to Blue Creek to meet with Vance Drain and Peter (last name not provided) from MWH, who were nearing completion of their reconnaissance.

The three objectives of the fieldwork are to:

- Identify and map sediment deposits within the lower Blue Creek drainage.
- Quantify sediment thickness and sediment surface area to calculate a rough volume estimate (+/- 50%) for each area.
- Report the findings in a brief technical memorandum utilizing maps to show depositional areas (e.g., beaver ponds), probe locations, measured sediment thicknesses and photographs of each area. In addition, a rough estimate of sediment volumes will be presented for the areas identified.

These goals should be met with the fieldwork observed and discussions with MWH about tasks they still needed to perform.

Following are informal observations from the field visit:

- The approach being made by Vance and Peter was to measure three key parameters at transects – width of fluvial deposits (bench width), width of active channel, and height of bench. They estimated that this was done at least every 500 meters and concentrated behind beaver dams.
- This approach seems sufficient to provide useful reconnaissance information. Results of this reconnaissance and the TM from it can help to begin to develop a conceptual site model that will contribute towards future efforts at characterization and sampling design.
- The details of the approach MWH used differed significantly from what was originally planned. Once they got into the field and began to understand site conditions and constraints, MWH did a good job of adapting to the field conditions and time available.
- Vance, Peter and Daniel agreed that an actual geomorphic mapping and sampling effort aimed at trying to quantify and identify the distribution of contaminated sediment in Blue Creek would be a 2-3 week field effort if this is planned for the future.

Observations and interpretations of Blue Creek sediment and geomorphology:

- After being there a 3rd time, I think beaver dams are an even more important influence on the sediment in Blue Creek than originally thought. I interpret that beaver dams are responsible for most of the stored sediment in the system. If any contaminated sediment is still present, it is either behind current beaver dams or left over from previous beaver dams.
- One interesting and relevant observation is that Blue Creek apparently does not flood often or at all, due to some not-as-yet understood reasons. Most of the deposits were laid down during in-channel flows, not floods. Given this, I think that most of the contaminated sediment must've been trapped behind beaver dams that were present at the time of the releases (1950s-1980s) just below where the Eastern Drainage enters Blue Creek. It would be helpful to try to understand the longevity and age of the two or three largest dams closest to the outfall point. Brian Crossley said that while many of the dams are probably newer (last 5 years), some of the bigger ones could have been present during mining period, and trapped contaminated sediment. The lack of floods to blow out beaver dams is an important factor in allowing them to persist for a long time (decades).
- The two main deposits in which contamination probably occurs are: (1) beaver dams, in-channel; and (2) the low bench that lines the channel throughout its length.
- Vance referred to the low bench as a "flood bench," which implies that it forms through vertical accretion overbank during floods. However, because of the lack of floods, I interpret that the low bench is created as a result of former beaver dams that have been breached. Once the dam is abandoned, the channel cuts down through the beaver dam deposits, leaving a bench from former in-channel deposits, and not formed by vertical accretion of flood layers. The hypothesis would predict that this "bench" varies in height, age, and contamination content depending on the height and age of the beaver dam that created them.
- If the above interpretation is correct, it would predict that although the benches are continuous along the channel, they are probably not contemporaneous, and this is important for documenting and mapping contamination in Blue Creek. The deposits that formed during the period of active mine waste discharges could contain much of the contamination, but other benches that are not of that age vintage may be clean.
- One piece of evidence for the bench being related to relict beaver dam deposits rather than flood benches, is that gravel was observed in them in at least one location. More observations like this would help confirm or contradict this hypothesis.

Beaver Dam photos:

Peter EerNisse

From: Lou Miller <lou.miller@wm-env.com>
Sent: Thursday, June 11, 2015 2:02 PM
To: Anthony Magliocchino; Vance Drain
Subject: FW: RE: Blue Creek Reconnaissance

From: Bill Lyle [mailto:William.Lyle@Newmont.com]
Sent: Wednesday, January 28, 2015 4:35 PM
To: HALE, ELLY; Lou Miller; fredk@aeseinc.com; connolly@spokanetribe.com; Vance Drain; Kira.Sykes@CH2M.com
Subject: RE: Blue Creek Reconnaissance

Good Afternoon attached is a description prepared by MWH for the Lower Blue Creek reconnaissance as we discussed yesterday and I committed to pass along.

SUBJECT: Lower Blue Creek Deposition Reconnaissance.

PURPOSE AND OBJECTIVES

The following memorandum presents the objectives, methods, and procedures that will be used to perform a reconnaissance survey of Lower Blue Creek in the stretch below the Ford-Wellpinit roadway to the Blue Creek Delta (i.e., lower Blue Creek). The purpose of the survey is to collect information to identify the presence of depositional sites along the drainage. The objectives of the survey are:

- Identify and map sediment deposits within the lower Blue Creek drainage.
- Quantify sediment thickness and sediment surface area to calculate a rough volume estimate (+/- 50%) for each area.
- Report the findings in a brief technical memorandum utilizing maps to show depositional areas (e.g., beaver ponds), probe locations, measured sediment thicknesses and photographs of each area. In addition, a rough estimate of sediment volumes will be presented for the areas identified.

SURVEY METHODS

1) Representatives of Newmont, CH2M Hill, and the Spokane Tribe will walk the Blue Creek drainage below the Ford-Wellpinit roadway to the Blue Creek Delta. This work has been proposed to commence 4 March 2015 and is expected to take two days to complete. All work will be performed in accordance with the Midnite Mine health and safety plan.

2) Representatives will map stream reaches and observed sediment depositional areas and collect associated data. This mapping will include:

a. Narrative description in a field logbook of each depositional area and the stream reach containing it (e.g., riffle, run, pool, bend, old and existing beaver ponds, large overbank flood deposits, etc.). Each depositional area identified will be named for future reference and identification on a map. The upper-most sediment present will be classified in the field using American Society for Testing Materials (ASTM) descriptions, color, plasticity, moisture and organic matter.

b. Photographs of each depositional area.

c. Estimate of the lateral extent of the depositional surface area made by GPS survey, direct measurements or a combination of both.

d. Estimate of sediment deposit thickness determined by penetrometer testing. One to three penetrometer tests will be performed at each depositional area to estimate the sediment thickness. The penetrometer testing will be performed by driving a six foot, 5/8-inch diameter steel rod into the sediment by hand or with a fence post driver. Rod refusal will indicate the penetrometer has reached the bottom of soft, saturated sediment and has encountered the firmer native soils.

REPORTING

MWH will prepare a technical memorandum within 45 days of the survey. The memorandum will present narrative text, maps, field observations, field measurements, photographs, and calculated sediment values obtained from the reconnaissance survey in addition to any conclusions and/or recommendations that can be made based on the survey.

From:	Lou Miller
To:	Anthony Magliocchino; Vance Drain
Subject:	FW: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.
Date:	Thursday, June 11, 2015 2:02:25 PM

From: Bill Lyle [mailto:William.Lyle@Newmont.com]
Sent: Tuesday, March 17, 2015 3:40 PM
To: Hale, Elly; Lou Miller; Fred Kirschner; connolly@spokanetribe.com; Vance.K.Drain@mwhglobal.com; Daniel.Malmon@CH2M.com; Keeley, Karen; crossley@spokanetribe.com
Cc: Kira Sykes
Subject: RE: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

Good Afternoon Elly and Karen:

Below are a few clarifications which Vance presented to your transmittal last week summarizing the conference call. I wanted to pass these along, since Vance was the one in the field I requested he address those items which he felt they would or would not be able to deliver. I have copied each of your bullet items and provide comment where we had questions regarding clarifications. Following your review if you have any questions please let us know.

Regards,
Bill

- A summary of the field reconnaissance ACTIVITIES (AND ANY CHANGES IN THE FIELD ACTIVITIES FROM THOSE DESCRIBED IN THE BRIEF WP)

  No comment we agree.

- a conceptual site model of the STREAM geomorphology, including sediment sources/transport/deposition/erosion (that relates to premining, mining, and post-mining periods).

  Comment: ELLY, ANY ATTEMPT TO CONNECT THE STREAM GEOMORPHOLOGY CSM TO THOSE BRIEF SNAP SHOTS IN TIME (UNDERLINED) WILL BE AN EDUCATED GUESS AT BEST AND LIKLEY WON'T EASILY FIT INTO THE GEOLOGIC TIME SCALE GENERALLY PRESENTED IN THE STREAM GEOMORPHOLOGY CSM. WE WILL DISCUSS HOW THE CSM MIGHT INFLUENCE THE DEPOSITION OF MINE-RELATED SEDIMENTS (E.G., WHERE THEY MIGHT BE FOUND). THIS SECTION WILL BE PRESENTED FOLLOWING THE DISCUSSION OF THE FIELD CONDITIONS AND DATA COLLECTION ACTIVITIES.

- maps and descriptions of the reaches and transects

No comment we agree.

- identification and estimated sizes/heights/ages of beaver dams.

  Comment: WE HAVE THE WIDTH AND HEIGHT OF MANY OF THE BEAVER DAMS, BUT NOT ALL OF THEM BECAUSE WE DIDN'T VISIT EVERY DAM. THE AGE WOULD BE A COMPLETE GUESS. WE MAY BE ABLE TO SAY THEY ARE ACTIVE OR INACTIVE AT THE TIME OF OUR VISIT FOR SOME LOCATIONS. REMEMBER THIS WAS A RECONNAISSANCE SITE VISIT TO BETTER UNDERSTAND HOW THE SYSTEM OPERATES.

- estimated sediment volumes in the beaver pond areas.

  Comment: ONLY THE UPPER TWO BEAVER PONDS THAT BRIAN CROSSLEY IS HELPING WITH

- hypotheses that can be tested/recommendations for next steps (for example: additional characterization to refine or verify CSM or test hypothesis of sediment behavior? Link sediment data to the CSM and tie geomorphology to overall Blue Creek assessment approach, assess impacts and benefits of sediment removal from stream, establish updated pre-construction chemical or other data…).

  Comment: WE CAN LINK THE HISTORIC DATA TO THE BLUE CREEK CSM IN SOME INSTANCES AND WILL ATTEMPT TO DO THAT THROUGH REVIEW OF THE PREVIOUS INVESTIGATIONS THAT ARE SUMMARIZED IN THE CURRENT DRAFT BLUE CREEK WORK PLAN. WE ALSO CAN DISCUSS IF THE SEDIMENT SAMPLING (TRIAD) APPROACH SUGGESTING IN THE BLUE CREEK WORK PLAN SHOULD BE MODIFIED BASED ON THE SITE RECONNAISANCE IN THE RECOMMENDATIONS SECTION OF THE SITE RECONN REPORT.

- annotated photos/field notes

  No comment we agree.

From: Hale, Elly [mailto:Hale.Elly@epa.gov]
Sent: Thursday, March 12, 2015 12:02 PM
To: Lou Miller; Fred Kirschner; connolly@spokanetribe.com; Vance.K.Drain@mwhglobal.com; Bill Lyle; Daniel.Malmon@CH2M.com; Keeley, Karen; crossley@spokanetribe.com
Cc: Kira Sykes
Subject: RE: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

Hi, all –

Thanks for joining the call (and Lou, thanks for saving us from the unfortunate limit on callers into EPA's conference line).

So, unless I've miscounted, 45 days from March 9 is April 22, 2015. We'll look forward to a

report that includes:

- A summary of the field reconnaissance (esp. how it changed from the brief work plan)
- a conceptual site model of the geomorphology, including sediment sources/transport/deposition/erosion and how that relates to premining, mining, and post-mining periods,
- maps and descriptions of the reaches and transects,
- identification and estimated sizes/heights/ages of beaver dams (note whether active or inactive),
- estimated sediment volumes in the beaver pond areas,
- hypotheses that can be tested/recommendations for next steps (for example: additional characterization to refine or verify CSM or test hypothesis of sediment behavior? Link sediment data to the CSM and tie geomorphology to overall Blue Creek assessment approach, assess impacts and benefits of sediment removal from stream, establish updated pre-construction chemical or other data…)
- annotated photos/field notes

Brian Crossley agreed to take and share measurements of sediment depth behind the two large beaver dams below the mine drainage, in the next few weeks, once the ice melts. This is to help estimate sediment volumes. Vance, you and Brian should discuss details of where/how many/what form you need the data?

This report will help assemble the approach for Blue Creek remediation, but it is not currently part of or instead of the Blue Creek and Delta Assessment work plan, which I will be discussing with Karen.

Did I miss or misstate anything? Let me know, if so.

Thanks,

Elly

Ellen Hale
US EPA Region 10
Office of Environmental Cleanup
1200 6th Ave, Suite 900, MS ECL-122
Seattle, WA 98101
(206) 553-1215
hale.elly@epa.gov

From: Lou Miller [mailto:lou.miller@wm-env.com]
Sent: Thursday, March 12, 2015 10:12 AM
To: Hale, Elly; Fred Kirschner; connolly@spokanetribe.com; Vance.K.Drain@mwhglobal.com; Bill Lyle; Daniel.Malmon@CH2M.com; Keeley, Karen; crossley@spokanetribe.com
Cc: Kira Sykes
Subject: RE: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

We can use mine – (b) (6) - code (b) (6)

From: Hale, Elly [mailto:Hale.Elly@epa.gov]
Sent: Thursday, March 12, 2015 11:10 AM
To: Fred Kirschner; connolly@spokanetribe.com; Vance.K.Drain@mwhglobal.com; Bill Lyle; Daniel.Malmon@CH2M.com; Keeley, Karen; crossley@spokanetribe.com; Lou Miller
Cc: Kira Sykes
Subject: RE: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

Hi, all – I think the line has room for SIX people to dial in on separate lines. Anyone willing to share a line? (We can't get in!)

Ellen Hale
US EPA Region 10
Office of Environmental Cleanup
1200 6th Ave, Suite 900, MS ECL-122
Seattle, WA 98101
(206) 553-1215
hale.elly@epa.gov

From: Hale, Elly
Sent: Tuesday, March 10, 2015 3:01 PM
To: Fred Kirschner; Randy Connolly; 'Vance.K.Drain@mwhglobal.com'; Bill Lyle; 'Daniel.Malmon@CH2M.com'; Keeley, Karen; Brian Crossley; 'lou.miller@wm-env.com'
Cc: Kira Sykes
Subject: RE: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

By the way, that's 10 am PACIFIC time, for those in other states.

I reserved the EPA conference line at (b) (6)

From non-EPA line into Conference Line:
Dial: (b) (6) (you'll hear a recorded message "You've reached EPA Region 10 Conference Gateway. Please enter 10 digit conference code")
Enter this number: (b) (6)
At prompt, enter access code: (b) (6)

From EPA line
Dial: (b) (6)
Enter access code: (b) (6)

Ellen Hale
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Seattle, WA 98101
(206) 553-1215

hale.elly@epa.gov

From: Hale, Elly
Sent: Tuesday, March 10, 2015 2:39 PM
To: Fred Kirschner; Randy Connolly; Vance.K.Drain@mwhglobal.com; Bill Lyle; 'Daniel.Malmon@CH2M.com'; Keeley, Karen; Brian Crossley; lou.miller@wm-env.com
Cc: Kira Sykes
Subject: This Thursday at 10 a.m.: Midnite Call re Blue Creek geomorphology: field observations, what should go into report, etc.

Hi, all –

I understand you've been out tromping along Blue Creek for several days, but Karen is out next week, and I'm out the following week.

We'd like to get on the phone with you all, Thursday or Friday, to make we are all clear what should be in the geomorphic field reconnaissance technical memorandum, due in 45 days.

This call probably won't address related questions, which we'll need to get to before long:

Appendix Y, the Blue Creek and Delta Assessment Plan – how the recent field work affects sampling, e.g. baseline sampling in 2015 or 2016

Fred's proposed approach versus the language in the ROD – how to move forward

Potential need for a more detailed geomorphologic study

I'm including a quick write-up prepared by Daniel, which highlights the role of beaver dams in retaining sediment in Blue Creek. Sounds like things went well, and that this work offers a good close-up perspective on the geomorphology.

So: Would 10 a.m. Thursday work for you all? Sounds like it works for me, Karen, Fred, Daniel, and Randy.

Let me know if you can manage that!

Elly

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not constitute a formal view and/or opinion of the company unless specifically stated.

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